International Journal of Distributed Systems and Technologies
Volume 8 • Issue 2 • April-June 2017

An Integrated Fuzzy-Based System for Cluster-Head Selection and Sensor Speed Control in Wireless Sensor Networks

Miralda Cuka, Fukuoka Institute of Technology, Fukuoka, Japan

Donald Elmazi, Fukuoka Institute of Technology, Fukuoka, Japan

Takaaki Inaba, Fukuoka Institute of Technology, Fukuoka, Japan

Tetsuya Oda, Fukuoka Institute of Technology, Fukuoka, Japan

Makoto Ikeda, Fukuoka Institute of Technology, Fukuoka, Japan

Leonard Barolli, Fukuoka Institute of Technology, Fukuoka, Japan

ABSTRACT

Cluster formation and cluster head selection are important problems in Wireless Sensor Network (WSN) applications and can drastically affect the network's communication energy dissipation. However, selecting the cluster head is not easy in different environments which may have different characteristics. In order to deal with this problem, in this paper, we implement an integrated fuzzy-based system for controlling sensor speed in WSNs. Different from our previous work, we consider 4 input linguistic parameters: Remaining Power of Sensor (RPS), Degree of Number of Neighbor Nodes (D3N), Distance from Cluster Centroid (DCC) and Sensor Speed (SS) for selection of the cluster-head and the control of sensor speed. By controlling the sensor speed, we are able to predict whether the node will leave or stay in the cluster. We evaluate the proposed system by simulations and show that the system has a good behavior.

KEYWORDS

Cluster-Head Selection, Fuzzy Logic, Sensor Speed Control, Wireless Sensor Networks

INTRODUCTION

The Wireless Sensor Networks (WSNs) can be deployed for many applications such as battlefield surveillance and environment constrained limitations make it essential for these sensor nodes to conserve energy to increase life-time of the sensor network monitoring. An important aspect of such networks is that the nodes are unattended, resource-constrained, their energy cannot be replenished and network topology is unknown. The resource-constrained limitations make it essential for these sensor nodes to conserve energy to increase life-time of the WSN (Akyildiz et al., 2002; Akyildiz & Kasimoglu, 2004; Giordano & Rosenberg, 2006; Al-Karaki & Kamal, 2004).

DOI: 10.4018/IJDST.2017040101

There are many fundamental problems that WSNs research have to address in order to ensure a reasonable degree of cost and system quality. Some of these problems include sensor node clustering, Cluster Head (CH) selection and energy dissipation. There are many research works that deal with these challenges (Chatterjee et al., 2002; Banerjee & Khuller, 2001; Chen, et al., 2004; Basagni, 1999; Amis, et al., 2000; Chan & Perrig, 2004; Heinzelman, et al., 2004; Heinzelman, et al., 2000; Lindsey, et al., 2002; Pal et al., 2012; Azad & Sharma, 2013).

The cluster based algorithms could be used for partitioning the sensor nodes into subgroups for task subdivision or energy management. Cluster formation is one of the most important problems in WSN applications and can drastically affect the network's communication energy dissipation. Clustering is performed by assigning each sensor node to a specific CH. All communication to (from) each sensor node is carried out through its corresponding CH node. Obviously, each sensor node can communicate with the closest CH node to conserve its energy. However, CH nodes can usually handle a specific number of communication channels. Therefore, there is a maximum number of sensors that each CH node can handle. This does not allow each sensor to communicate to its closest CH node, because the CH node might have already reached its service capacity. CHs can fuse data from sensors to minimize the amount of data to be sent to the sink. When network size increases, clusters can also be organized hierarchically.

In the conventional cluster architecture, clusters are formed statically at the time of network deployment. The attributes of each cluster, such as the size of a cluster, the area it covers, and the members it possesses, are static. When a sensor with sufficient battery and computational power detects (with a high Signal-to-Noise Ratio: SNR) signals of interest, it volunteers to act as a CH. This is a simple method, because no explicit leader (CH) election is required and, hence, no excessive message exchanges are incurred. However, selecting of the CH in this way is not easy in different environments which may have different characteristics such as error rate, SNR, throughput and so on.

The heuristic approaches based on Fuzzy Logic (FL) and Genetic Algorithms (GA) can prove to be efficient for traffic control in wireless networks (Chan, Sheriff, Hu et al., 2001; Barolli, Koyama, Suganuma & Shiratori, 2003). In our previous work (Anno et al., 2007; Elmazi et al., 2015a, b), we proposed a fuzzy-based cluster selection method for wireless sensor networks, which uses 3 parameters for CH selection: Distance of Cluster Centroid, Remaining Battery Power of Sensor and Number of Neighbor Nodes. We compared the performance with a previous method. The performance of our method was better than the previous method. But, we found that for CH selection also sensor speed is very important.

For this reason, in this paper, we propose and implement an integrated Fuzzy-based Sensor Speed Control System with 4 Parameters (F2SCS-4P). We evaluate F2SCS-4P by computer simulations and show that the proposed system has a good behavior.

The paper is organized as follows. In the next section, we show some related work. Then, we describe the proposed F2SCS-4P system. In following, we discuss the simulation results. Finally, we present the conclusions.

RELATED WORK

In this section, we review related work in clustering algorithms. Several clustering methods such as weighted clustering (Chatterjee, Das & Turgut, 2002), hierarchal clustering (Chen, How & Sha, 2004) and dynamic clustering (Basagni, 1999) algorithms have been proposed to organize nodes as a cluster. Most algorithms elect CHs based on certain weights or iteratively optimize a cost function or use heuristic to generate minimum number of clusters.

The Distributed Clustering Algorithm (DCA) (Amis, Prakash, Vuong & Huynh, 2000) assumes quasi-stationary nodes with real-valued weights. The Weighted Clustering Algorithm (Chatterjee, Das & Turgut, 2002) elects a node based on the number of neighbors, transmission power and so on. The

Related Content